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POTASH FROM TULE

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FERTILIZER VALUE OF CERTAIN MARSH PLANTS

BY

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POTASH FROM TULE AND THE FERTILIZER VALUE OF CERTAIN MARSH PLANTS.

By P. L. Hibbard.*

A brief study indicates that 100 to 200 pounds of potash to the acre, worth at present prices, $15.00 to $30.00, may be obtained from a heavy growth of tule, at a cost of perhaps $5.00 to $10.00 per acre. Though this study is not extensive, the facts developed seem of sufficient importance to warrant publication without further delay.

Tule land usually has great agricultural value after it has been reclaimed from its marshy condition. It is thought that much of the expense of reclamation may be defrayed by the value of the potash contained in the marsh vegetation. At the present time any source from which potash may be obtained at reasonable cost is of much interest. Whether a profitable industry of extracting potash from tule can be developed remains to be proved by actual experience on a large scale. The object of this paper is to bring the matter to the attention of those whom it may interest, with the hope that commercial enterprise will demonstrate its possibilities.

Description, Location and Habits of Tule.

The tule plant (*Scirpus lacustris, var. occidentalis*) is a member of the botanical family of sedges frequently seen growing in the edges of ponds or in marshy places. It is closely related to the common bulrush of the eastern portion of the United States. The plant sends up an annual growth of round, tapering dark green stems, four to ten feet high and one-fourth to one inch thick at the base, tapering to a point at the top which often bears a small bunch of flowers or seeds. With the tule are commonly found other water-loving plants, such as the sedges, grass-like plants of smaller size having a triangular stem; and cattails, often called flags, which have long flat leaves surrounding the base of a tall round stalk at the top of which is a brown cylindrical mass of seed commonly known as cattail. All these and some others grow in quiet, shallow water. Where the water never dries up they are largest. After the water disappears the tule ceases to grow, but many of the sedges and cattails continue to flourish as long as the ground is moist. All produce an annual growth which dies during the winter.

The area of tule land in California is estimated at 500,000 acres. Much of this has been reclaimed but it is thought that there still remains in the delta region of the San Joaquin and Sacramento rivers alone 50,000 acres largely covered with tule. On much of this ground the growth is too sparse or too inaccessible to be of much value. In many other parts of the state are considerable areas of tule land. In overflowed regions the tule is found over broad areas, but is most luxuriant along the edges of sloughs and channels in strips ten to twenty feet wide, where it always has a good supply of water. It grows in both fresh and brackish, but not in salt, water.

The weight of tule on an acre is exceedingly variable. Measurements of small areas in a number of places indicate that the green plants on one square foot weigh one-half to over one pound which would make ten to twenty tons per acre. In drying three-fourths of the weight is lost. The following Table I indicates the source and condition of the plants studied.

*Note.—Grateful acknowledgment is made to Professor J. S. Burd for valuable counsel and suggestions.

TABLE I.

Location, Condition, Etc., of Plants Analyzed.

No.	Name	Condition of plants	Locality	Water depth, inches	Height of plant, feet	Number stems in sample	Date of sampling
1	Tule	Fresh	Stockton	6	5–6	25	May 15
2	Tule	Fresh	Alvarado	2–10	4–8	20	May 28
5	Tule	Fresh	Mallard	0–6	10	1	June 11
6	Tule	Fresh	Mallard	0–6	8	1	June 11
11	Tule	Fresh	Benicia	2–6	4–7	6	June 11
15	Tule	Fresh	Suisun	2–6	5–7	3	June 11
17	Tule	Fresh	Newman	------	4–6	20	June 15
18	Tule	Fresh	Newman	------	3–4	20	June 15
20	Tule	Fresh and 1/10 dead	Middle River	2–12	4–8	15	July 13
21	Tule	Fresh	Middle River	12–24	4–8	15	July 13
23	Tule	Fresh and 1/10 dead	West Pittsburg	0–6	5–8	15	July 20
27	Tule	1/3 dead	Lisbon	None	5–7	20	July 26
30	Tule	Fresh	Lisbon	2–12	5–8	10	July 26
28	Tule and sedge	1/3 dead	Lisbon	None	5–7	20	July 26
24	Tule, sedge, cattail and weeds	1/3 dead	Lisbon	None	4–6	25	July 26
25			Lisbon	None	4–6	25	July 26
26			Lisbon	None	4–6	25	July 26
4	Tule	Dead	Alvarado	2–10	4–8	20	May 28
9	Tule	Dead	Mallard	0–6	6	5	June 11
3	Sedge	Fresh	Alvarado	0–2	2–3	10	May 28
10	Sedge	Fresh	Benicia	2–6	4	3	June 11
13	Sedge	Fresh	Suisun	2–6	4–6	3	June 11
7	Cattail	Fresh	Mallard	0–6	5	1	June 11
12	Cattail	Fresh	Benicia	2–6	5	2	June 11
14	Cattail	Fresh	Suisun	2–6	5	3	June 11
22	Cattail	Fresh	Bay Point	2–4	3–5	10	July 20
8	Cattail	Dead	Mallard	0–6	5	1	June 11
16	Cattail	Dead	Suisun	2–6	5	2	June 11
29	Fire weeds	Fresh	Lisbon	None	3–5	15	July 26

Composition of Various Plants.

The composition of the tule plants varies greatly, as is indicated by Table II following. A few analyses indicate that the young plants contain the highest proportion of potash, though the old plants may give a greater yield of potash per acre on account of the larger tonnage. Reasoning by analogy from our definite knowledge of other plants we should reach the same conclusion. This study is not yet sufficiently extensive to prove the theory in regard to tule. However, it is definitely shown that dead plants or those which have been leached by water retain only a small amount of potash.

Effect of Leaching.

The loss of potash by leaching is shown by the following experiment: A bunch of the stems was soaked in water overnight. The water was poured off and the stems again covered with fresh water to stand another day; this was repeated once more. Finally potash was determined in the different extracts. Of the total potash present before soaking 15 per cent remained in the stems, 58 per cent was in the first leaching, 18 per cent in the second leaching, and 9 per cent in the third leaching. This indicates that a large portion of the potash is not organically combined in the plant, and shows that to obtain much potash the plants must be harvested before rain washes out the valuable salts.

TABLE II.

Percentage—Composition of Plants.

No.	Name	Condition of plants	Fresh material: Water	Fresh material: Ash	Fresh material: K_2O	Water-free material: Nitrogen	Water-free material: P_2O_5	Water-free material: K_2O	Water-free material: Ash	Water-free material: K_2O in ash
1	Tule	Fresh	76.5	3.1	0.77	1.86	0.71	3.3	12.9	25.4
2	Tule	Fresh	75.0	3.1	0.42	------	------	1.7	12.2	13.8
5	Tule	Fresh	75 est.*	3.7	1.23	1.28	0.51	4.9	14.8	32.7
6	Tule	Fresh	75 est.*	3.3	0.95	1.80	0.62	3.8	13.2	28.8
11	Tule	Fresh	75 est.*	2.8	0.80	------	------	3.2	11.3	28.3
15	Tule	Fresh	75 est.*	3.0	0.75	1.19	0.41	2.9	12.1	23.2
17	Tule	Fresh	75 est.*	2.6	0.75	0.91	------	2.9	10.6	26.6
18	Tule	Fresh	75 est.*	2.7	0.80	------	------	3.2	10.7	30.0
20	Tule	Fresh and 1/10 dead	75.8	2.4	0.26	1.43	0.48	1.1	10.0	11.0
21	Tule	Fresh	68.4	2.2	0.57	1.17	------	1.8	6.8	26.5
23	Tule	Fresh and 1/10 dead	77.5	2.7	0.48	1.25	------	2.2	11.9	18.3
27	Tule	1/3 dead	58.3	3.9	0.92	0.75	------	2.2	9.4	23.4
30	Tule	Fresh	75 est.*	-----	0.39	------	------	2.3	16.5	14.5
28	Tule and sedge	1/3 dead	52.0	4.8	1.01	------	------	2.1	10.1	20.8
24	Tule, sedge, cattail and weeds	1/3 dead	54.4	4.7	1.00	------	------	2.2	10.3	21.3
25	Tule, sedge, cattail and weeds	1/3 dead	54.4	4.3	1.05	------	------	2.3	9.4	24.4
26	Tule, sedge, cattail and weeds	1/3 dead	60.0	3.2	0.76	0.70	0.40	1.9	8.1	23.4
4	Tule	Dead	63.1	3.7	0.99	------	------	2.7	10.1	25.8
9	Tule	Dead	50 est.*	6.6	0.05	0.78	0.15	0.1	13.3	0.8
3	Sedge	Fresh	85.9	1.8	0.52	1.86	0.54	3.9	13.0	30.0
10	Sedge	Fresh	85 est.*	3.0	0.45	2.02	0.51	3.0	19.8	15.2
13	Sedge	Fresh	85 est.*	2.3	0.63	1.95	0.51	4.2	15.6	27.0
7	Cattail	Fresh	75 est.*	2.9	0.87	1.55	0.52	3.5	11.8	30.0
12	Cattail	Fresh	75 est.*	3.6	0.57	------	------	2.3	14.5	16.5
14	Cattail	Fresh	75 est.*	2.8	0.88	------	------	3.5	11.0	31.7
22	Cattail	Fresh	72.2	2.0	0.31	0.95	0.48	1.1	7.0	14.9
8	Cattail	Dead	50 est.*	3.8	0.60	0.94	0.52	1.2	7.5	16.0
16	Cattail	Dead	50 est.*	3.1	0.15	0.53	0.32	0.3	6.2	4.8
29	Fire weeds	Nearly fresh	62.5	2.1	0.64	0.71	0.31	1.7	5.5	30.9

*Est. indicates that amount of water was estimated, not actually determined.

The amount of potash in tule ash is also quite variable, as will be seen by a study of Table II. It seems probable that plants growing in a scanty supply of water or in saline water carry a larger proportion of potash in the ash.

Composition of Tule Ash.

This has been only slightly studied. A proximate analysis of the ash is given in Table III. From this it seems that the potash in the tule is largely present in mineral condition and not organically combined as in most land plants. In this respect it resembles the kelps of the ocean. This ash was obtained by burning several pounds of sample No. 2 on an iron plate in open air. It was separated by leaching with water into the insoluble and the water-soluble portions.

TABLE III.

The total ash contained:		
Unburnt carbon	14.4 per cent	
Water insoluble mineral matter	40.3 per cent	
Water soluble salts	45.3 per cent	
		100.00 per cent
The water soluble salts consisted of:		
Na_2O	8.0 per cent	
K_2O	16.8 per cent	
Cl	14.4 per cent	
SO_3	4.7 per cent	
CO_2	1.4 per cent	
		45.3 per cent

The water-insoluble mineral matter consisted of sand, clay, iron oxid, etc., with a little lime and magnesia.

Harvesting the Tule.

As above indicated the tule should be harvested before the leaching action of rain begins, probably best during September or sooner.

The crop may be cut with an ordinary mowing machine if the ground is dry enough to bear a team. After it has dried somewhat it may be raked into piles and carried to a smooth spot of hard ground from which the ashes may be easily shoveled up after the tule is burned. It will not be necessary to wait till it is very dry to burn it as after the fire is once started it will furnish heat enough to keep burning comparatively green material. This is desirable in order to avoid a very high temperature which would be liable to cause loss of potash.

The quantity of dry material and amount of potash per acre with other conditions are indicated in Table IV.

The rankest growth of tule is found along the edges of streams and swamps where there is always more or less water, so that it will never be possible to harvest it by means of an ordinary mowing machine. It is not probable that hand-cutting will pay. A machine something like a grain harvester mounted on a scow would probably be able to cut the tule cheaply (and convey it to a spot where it could be dried and burned). The whole operation must be well planned and worked out so as to handle the crop very inexpensively because the value of the product is not great enough to bear any costly method of harvesting.

TABLE IV.

Yield of Air-Dry Material and Potash.

No.	Name	Location	Per cent potash		Yield per acre (lbs.)		Depth of water on ground
			In air-dry material	In ash	Air-dry material	Potash	
20	Tule	Middle River	1.0	11.0	18,000	171	1 ft.
21	Tule and 10% cattail	Middle River	1.6	26.5	12,000	212	2 ft.
23	Tule	West Pittsburg	2.0	18.3	13,000	254	½ ft.
27	Tule	Lisbon	2.0	23.4	6,000	102	None
28	Tule and sedge	Lisbon	1.9	20.8	7,000	134	None
22	Cattail	Bay Point	1.0	14.9	15,000	157	½ ft.
24	Tule, sedge, cattail, weeds	Lisbon	2.0	21.3	4,000	87	None
25		Lisbon	2.1	24.4	4,000	87	None
26		Lisbon	1.7	23.4	5,000	86	None

Extraction of Potash From the Ash.

It is shown above that much of the potash may be extracted from tule by leaching, but in general it will be simpler to burn it first. The dry hay burns easily. All that is necessary is to get it onto ground where the ash can be easily recovered, and to avoid high temperatures which would cause loss of potash. After burning, it will probably be desirable to moisten the ash which is very light, in order to prevent loss by blowing. The ash may be used directly as a potash fertilizer or it may be leached with water to make high-grade potash salts. If the water is made to percolate slowly through the ash, the first runnings, in volume about equal to the volume of the ash, will contain most of the potash. Fresh water will then extract more of the potash. The weak extract thus obtained should be used instead of fresh water to extract new ash. In

this way most of the potash will be obtained with a minimum amount of water which must be evaporated to obtain the potash salts. The first crystallization of salts from the leachings is largely composed of potassium chloride and surlate, containing nearly 50 per cent K_2O. Further evaporation and crystallization yields a product containing less potash. The process should be similar to that used in obtaining potash from wood ashes.

In order to manufacture high-grade potash salts from tule a considerable plant and experienced management will probably be required, therefore such manufacture is not here advocated. The present object is rather to indicate the possibility of obtaining at small expense, by inexperienced persons, tule ash containing potash in a form which may be used as a fertilizer and in some measure help to pay the cost of recovery of the land.

Comparison of Tule With Other Sources of Potash.

Crude tule ash contains 7 to 15 per cent K^2O, which is more than most wood ashes contain. The tule ash here meant is the crude ash containing much carbon and soil, not the pure ash given in Table II. The percentage of crude ash is considerably greater than of the pure ash. Unlike wood ashes, in which most of the potash is present as carbonate there is but little of this form in tule ash. In this particular it is quite similar to kelp ash, which contains most of its potash as chloride. In other respects it is not similar to kelp ash.

The available potash in tule ash is similar to that of carnallite from the Stassfurt mines, which contains about 10 per cent of K_2O, chiefly in the form of chloride. Part of the tule potash is in the form of sulfate. The tule ash should be preferable to carnallite or kainit as a fertilizer because it contains less of the other undesirable chlorides. Like the other sources of potash above mentioned, tule ash is not suitable for mixing with other materials to make high-grade fertilizers because the large amount of inert material in it would lower the grade of the complete fertilizer. The high-grade potash salts obtained by extracting tule ash would be suitable for high-grade fertilizers.

Fertilizer Value of Tule.

Reference to Table V will show that tule has considerable value as a source of plant food. If plowed under it will probably decay readily, thus liberating its plant food and at the same time furnishing valuable humus which is commonly needed in California soils. As a source of plant food the fresh tule compares well with barnyard manure and other waste materials, such as straw or leaves. Like these it is not valuable enough to bear high cost of transportation, so that it must be used near where it grows. However, tule land itself is not likely to be benefited by the addition of tule as a fertilizer.

TABLE V.

Plant Food in Various Species of Marsh Growth.

(Pounds in one ton of fresh material.)

No.	Name	Nitrogen	P_2O_5	K_2O
1	Tule	9.2	3.6	15.4
5	Tule	6.4	2.6	24.6
6	Tule	9.0	3.1	19.0
15	Tule	6.0	2.0	14.5
9	Tule, dead	7.6	1.5	1.0
7	Cattail	7.8	2.6	17.5
22	Cattail	5.3	2.8	6.2
16	Cattail, dead	5.3	3.2	3.0
3	Sedge	5.2	1.5	10.6
10	Sedge	6.0	1.4	9.0
13	Sedge	5.8	1.4	12.6

As a fertilizer material the tule has some resemblance to the potash-bearing kelps of the Pacific Coast.

Fresh kelp (*Macrocystis pyrifera*), according to Burd*, contains in 1 ton about 4 pounds of nitrogen, 2 pounds phosphoric acid and 36 pounds of potash. Fresh tule contains about 6 pounds of nitrogen, 2 pounds phosphoric acid, 12 pounds of potash. Barnyard manure contains about 2 pounds of nitrogen, 2 pounds phosphoric acid and 4 pounds of potash per ton. All of these figures vary considerably with season, locality and treatment of the particular material. The tule has a considerable advantage over kelp in that it readily dries and may be burnt to an ash which has commercial value as a source of potash, while kelp is not easily dried and burnt.

While recovery of potash from tule may not be commercially profitable as such, where there is no intention to utilize the land, it is quite possible that this source of income may permit the recovery of lands which could not otherwise be reclaimed economically.

Summary.

1. California marsh vegetation, particularly tule, contains potash which may be somewhat easily obtained and thus help to pay cost of reclaiming the land.
2. Tule growth along sloughs, etc., contains potash worth recovering for its own sake.
3. Tule may be cut by a mowing machine and easily dried and burnt to obtain the ash.
4. The potash is recovered in the ash by burning the dry plants.
5. The ash may be used directly as a potash fertilizer or from it may be extracted high-grade potash salts by simple, inexpensive methods.
6. The ash is similar to kainit as a source of potash.
7. Dead or leached plants have lost most of their potash.
8. The tule plant has a fertilizer value comparable to that of barnyard manure or Pacific coast kelps.
9. Potash recovery from tule may never become a source of great wealth, but it may be of considerable local importance as a source of potash at times such as the present when potash is very scarce and costly.

*Bulletin 248, page 204, of this station.

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